# The Future of Arctic Shipping Along the Transpolar Sea Route

Malte Humpert and Andreas Raspotnik

*Arctic sea ice is melting rapidly, and within the next decade polar warming may transform the region from an inaccessible frozen desert into a seasonally navigable ocean. The debate over Arctic shipping routes routinely revolves around the Northwest Passage (NWP) and the Northern Sea Route (NSR), but neglects to make mention of the Transpolar Sea Route (TSR). In the 20th century the use of Polar routes revolutionized international air travel. In similar fashion, the TSR bears the potential to transform the international commercial shipping industry in the 21st century. The authors will discuss the potential of the TSR as a future corridor of commercial shipping and conduct a comprehensive analysis of the climatic, legal, economic, and geopolitical context. The article will examine the feasibility of the TSR with respect to the continued decline of Arctic sea ice and analyze the economic potential of the route and its compatibility with existing trade patterns. The authors will also discuss the TSR's special status as the only Arctic shipping route outside of national territorial jurisdiction. Special emphasis will be given to China's emerging interest in Arctic shipping and its growing economic relationship with Iceland, which stands to gain massively if it were to develop into a transpolar shipping hub. The opening and future development of Arctic shipping routes will not only depend on favorable climatic conditions across the Arctic Ocean, but will also be influenced by a shift in economic and political spheres of influence. The development of the TSR and its significant economic potential may thus in part be determined by key geostrategic considerations as the center of economic and political power continues to shift towards Asia. This multi-faceted and interdisciplinary study aims to outline and elaborate on a range of key issues and challenges related to the future of the TSR.*

## Introduction

The introduction of polar routes for flights between North America and the Far East at the end of the 20th century had a lasting impact on air travel and allowed for more cost-effective flights between the two continents by shortening flight times and reducing fuel costs. With the Cold War over and the subsequent modernization of air traffic control systems in the former Soviet Union, the main obstacles for routine transpolar flights had been removed. Today a number of rules and regulations govern these increasingly popular flight routes. 30,000 feet below, across the Arctic Ocean, three shipping routes have a comparable potential to transform commercial shipping in the 21st century:

Malte Humpert is Executive Director of the Arctic Institute. Andreas Raspotnik is an Analyst with the Arctic Institute and EXACT Marie Curie ITN Research Fellow with the University of Cologne.

the Northwest Passage (NWP), the Northern Sea Route (NSR), and the Transpolar Sea Route (TSR). In addition, the Arctic Bridge, a shipping route linking the Arctic seaports of Murmansk (Russia) and Churchill (Canada), could also develop into a future trade route between Europe and Asia.

This paper will assess the feasibility of the TSR from a climatic and economic standpoint and discuss how legal and geostrategic considerations will influence the development of this shipping route. In contrast to the NWP and the NSR, the TSR has thus far been neglected in the realm of academia and in the public eye. The authors conclude that the opening and future development of Arctic shipping routes will not only depend on favorable climatic conditions across the Arctic Ocean, but will also be influenced by a shift in economic and political spheres of influence. The development of the TSR and its significant economic potential may in part be determined by key geostrategic considerations as the center of economic and political power continues to shift towards Asia.

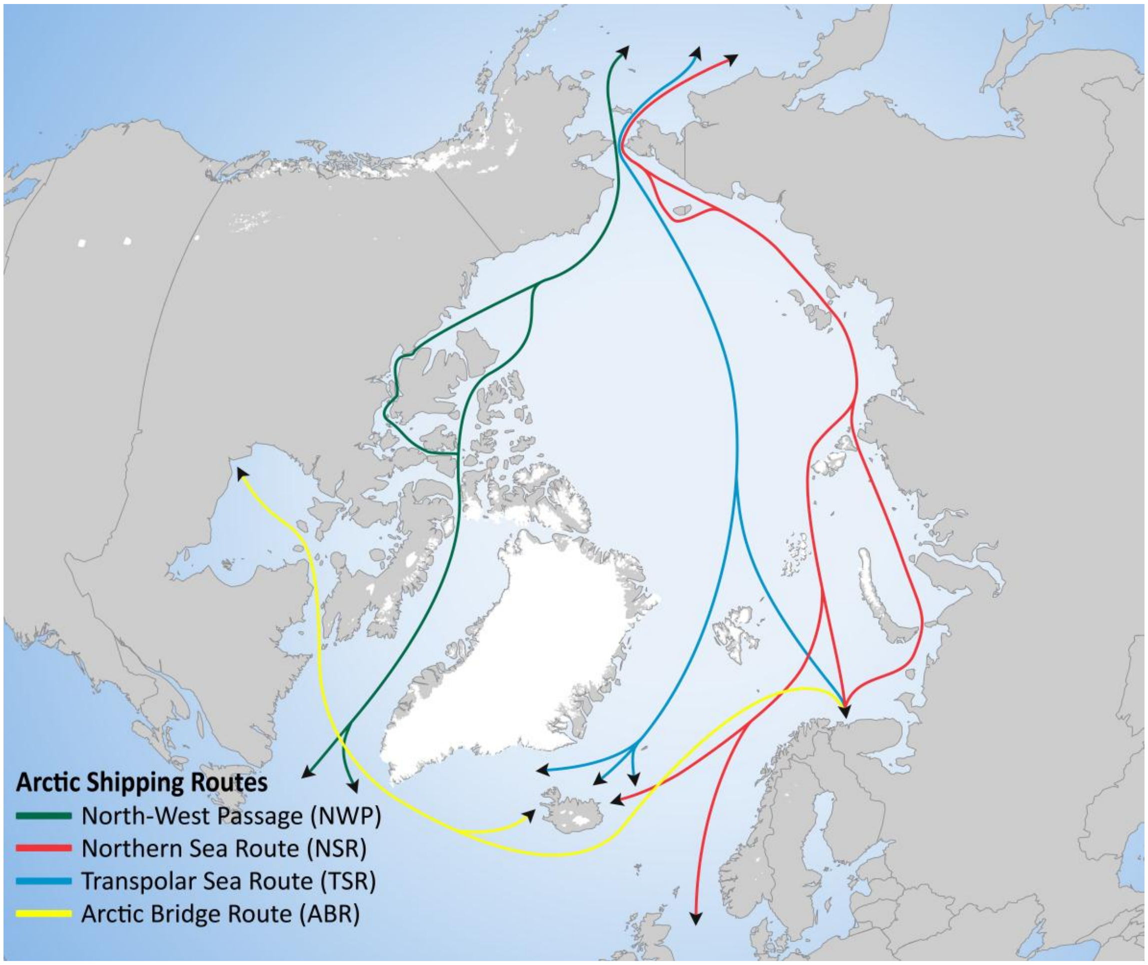


**Figure 4 Major Arctic Shipping Routes**
Author's own work. Adapted from *The Arctic Portal* (2012). Retrieved (05.3.12) from, http://portal.inter-map.com/#mapID=26&groupID=94&z=1.0&up=697.3&left=0.0

The TSR represents the most direct route for trans-Arctic shipment but has yet to attract significant commercial interest, as multi-year ice remains a formidable obstacle for most of the Arctic shipping season.[1] The effects of climate change are, however, increasingly observed throughout the region and the Arctic is now warmer than it has been at any time during the last 2,000 years (Jones, 2011). Summer ice extent has declined by 40% since satellite observation began in 1979 (NSIDC, 2010). Over the same period, Arctic sea ice has thinned considerably, experiencing a decline in average volume of 70% (Polar Science Center, 2012). Within the next decade this warming trend may transform the region from an inaccessible frozen desert into a seasonally navigable ocean and the Arctic Ocean may be ice-free for short periods as early as 2015 (AMSA, 2009: 4).

Notable research on potential future Arctic shipping scenarios includes, among others, Østreng's *Arctic Yearbook 2012* article "Shipping and Resources in the Arctic Ocean". A study of the feasibility of Arctic shipping for the time period between 2030-50 by Det Norske Veritas (2010) comes to the conclusion that the TSR will for the foreseeable future remain an unviable option for Arctic shipping due to unfavorable climatic conditions. Yet Schøyen and Bråthen (2011) arrive at a more favorable outlook on Arctic shipping in general and state that "shipping operations in the summer time via the NSR may already today be profitable" (977) and that additional shipping routes, i.e. the TSR, will allow for more flexibility in Arctic shipping. According to Huebert et al. "the development of northern shipping routes is not a question of if, but when" (Huebert, Exner-Pirot, Lajeunesse & Gulledge, 2012: 1). The *Arctic Marine Shipping Assessment* (AMSA), the most prominent official assessment on Arctic shipping, differentiates between four types of traffic: destinational transport, intra-Arctic transport, trans-Arctic transport and cabotage (AMSA, 2009: 12). AMSA defines trans-Arctic navigation as a full voyage between the Pacific and Atlantic Ocean or *vice versa* (AMSA, 2009: 12).

Seaborne trade currently accounts for 90% of world trade (Shipping Facts, 2012) and is dominated by the transportation of raw materials, tanker trade, and other dry cargo, including containerized cargo (UNCTAD, 2011). The growing importance of the trade relationship between Europe and Asia and the resulting increase in seaborne traffic between the two regions will result in further congestion and a higher risk of collisions along the existing sea routes and their choke points, e.g. the Suez Canal and the Strait of Malacca.

Trans-Arctic shipping, regardless of the actual route used, will not serve as a substitute for existing shipping routes, but will instead be supplemental and provide additional capacity for a growing transportation volume. For the foreseeable future, the limited seasonal window for trans-Arctic voyages must be taken into account in any projections. Nonetheless, the development of Arctic offshore hydrocarbon resources and related economic activities will result in an improved integration of the Arctic economy in global trade patterns.

The Arctic region has become increasingly politicized, affecting its future development and influencing the policy decisions of Arctic countries. The Arctic Ocean's potential economic and geostrategic importance has also begun to attract the attention of non-Arctic actors, who are in the process of defining their interests and intentions. The People's Republic of China, in addition to the European Union (EU), is arguably the most important non-Arctic actor and will be instrumental to the development and future of the TSR.

In 2011 China surpassed the EU and the United States (US) to become the world's largest exporter (CIA, 2012) and its gross domestic product (GDP) (purchasing power parity) is expected to surpass that of the US by 2019 (Euromonitor, 2010). China's growing demand for natural resources and its economic dependency on foreign trade[2] along a limited number of trade routes have led Chinese officials on a search to overcome this strategic vulnerability by securing new lanes of communication. Shipping routes across the Arctic Ocean may feature prominently in China's effort to diversify its portfolio of trade routes.

With a length of approximately 2,100 nautical miles (nm) (as cited in Ministry of Foreign Affairs Iceland, 2007: 7) the TSR is the shortest of the three Arctic shipping routes. While the NWP and the NSR are considered coastal routes, the TSR represents a mid-ocean route across or near the North Pole. Due to climatic uncertainty and constantly changing navigational and sea ice conditions, the TSR does not follow one single specific track but exists along a multitude of possible navigational routes. The TSR represents a variable non-coastal sea-lane across the Arctic Ocean, including a route closer to the NSR but outside of the Russian Exclusive Economic Zone (EEZ). Seasonal and annual variations in sea ice conditions will define the exact range of possible shipping lanes along the TSR.

The authors will conduct a multi-level risk assessment based on Schøyen and Bråthen (2011) to overcome the difficulty of making sound and reliable projections involving highly uncertain variables. In order to arrive at a comprehensive analysis regarding the future development of the TSR this article will describe environmental and climatic uncertainties; outline the current international legal situation; assess the economic feasibility, and identify economic risk factors; and take measure of behavioral uncertainties, including changing global trade patterns and emerging geopolitical considerations.

## Environmental and Climatic Uncertainties

**Climatic** Uncertainties & Opportunities

- Climate models predict a largely ice-free Arctic Ocean during the summer months by 2030
- Ice-free period along shipping routes >100 days by 2050
- Rapid loss of multi-year ice and decline of ice volume
- Obstacles for Arctic shipping may increase due to ice melt
- Harsh Arctic shipping environment due to e.g. icing from sea spray, remoteness, limited reliable weather forecasts

The Arctic Ocean is on an accelerating trajectory to a new, seasonally ice-free state. The Intergovernmental Panel on Climate Change (IPCC) estimates that over the next century, Arctic temperature rises will exceed the global annual mean by a factor of four and will range between 4.3 degrees Celsius (°C) and 11.4°C in the winter and 1.2°C and 5.3°C in the summer (Meehl et al., 2007). In the summer of 2007, the Arctic witnessed a dramatic sea-ice collapse due to above average temperatures, strong winds, and changes in ocean circulation. The ice has since failed to rebound to pre-2007 levels and may have passed a tipping point beyond which rising air temperatures are no longer the primary cause of ice loss, and where "self destructive dynamics take over" (Anderson, 2009: 89). During the 2012 melt season Arctic sea ice declined yet again at a remarkable pace and a new record low for ice extent, area, and volume was set.

Studies differ widely in their predictions of when summer sea ice will melt completely. Prior to the events of 2007, the IPCC forecasted an ice-free Arctic for the latter part of the 21st century (Meehl et al., 2007). The panel reported "the projected reduction [in global sea ice cover] is accelerated in the Arctic, where some models project summer sea ice cover to disappear entirely in the high-emission A2 scenario in the latter part of the 21st century" (Meehl et al., 2007: 750).

Yet studies published since the sea ice collapse of 2007 expect a dramatic reduction of summer ice in the first half of the 21st century. In an interview with National Geographic, Mark Serreze from the National Snow and Ice Data Center (NSIDC) in Boulder, Colorado stated "we are on track to see an ice-free summer by 2030 (as cited in Vidal, 2011). A study by Wang & Overland, which combined observational data with climate models, estimates that the Arctic will be nearly ice free at the end of summer in three or four decades (Wang & Overland, 2009).

The latest findings suggest that Arctic sea ice may have indeed entered into a new state of low ice cover, which "is distinct from the normal state of seasonal sea ice variation" (Livina & Lenton, 2012: 1). According to Tim Lenton at the University of Exeter, Arctic ice has crossed a tipping point, which could soon make ice-free summers an annual feature across most of the Arctic Ocean (as cited in Pearce, 2012). His findings appear to confirm an earlier study stating that Arctic ice is shrinking so rapidly that it may vanish altogether in as little as four years time (Collins, 2011).

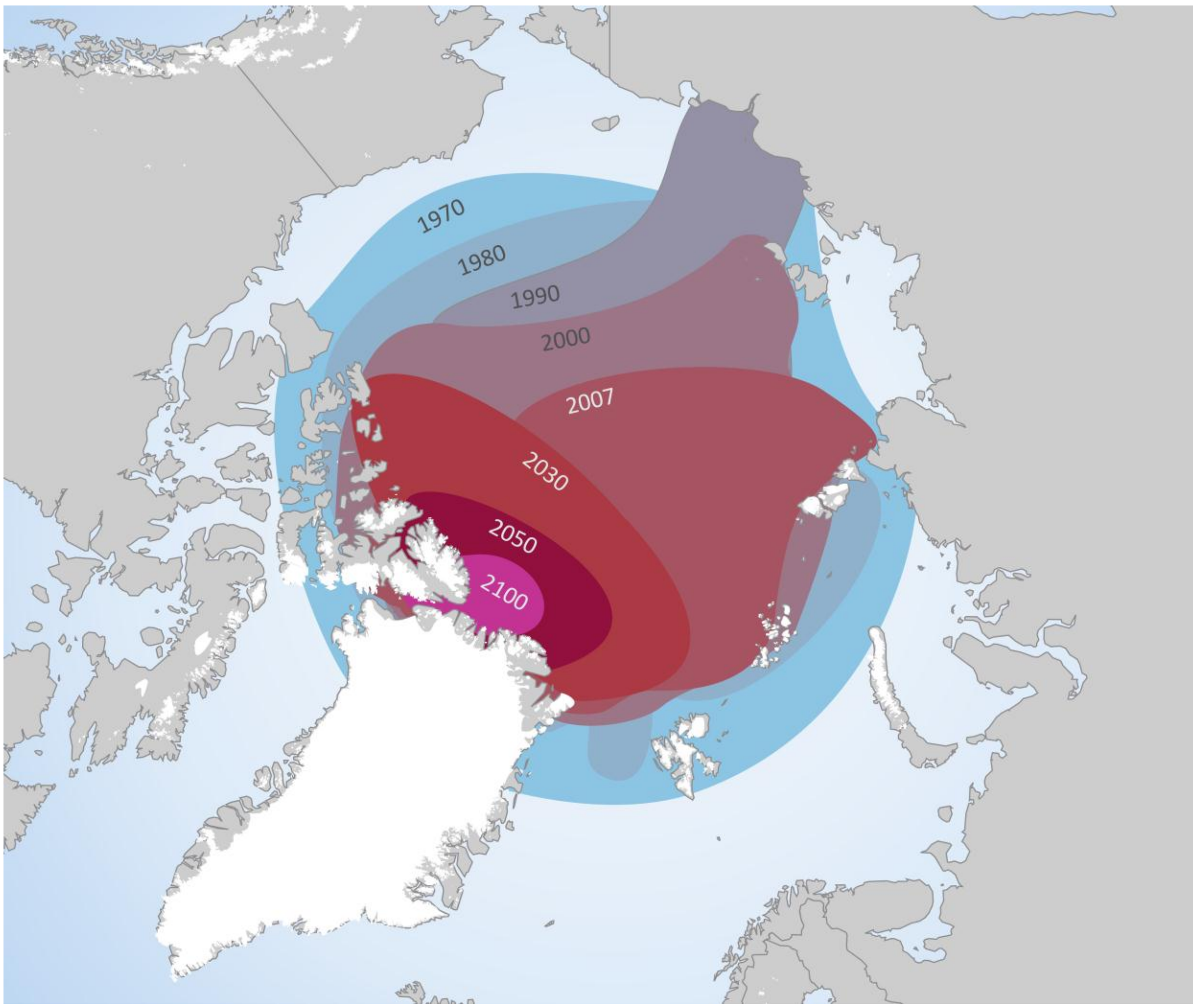


**Figure 5 Arctic Sea Ice Minimum Extent Observations 1970-2007 and Forecasts 2030-2100**
Author's own work. Adapted from Wunderground (2012). Arctic sea ice decline. Retrieved (05.18.12) from, http://www.wunderground.com/climate/SeaIce.asp using data from the NOAA GFDL model. Yearly extent represents an average 80% sea ice concentration.

A new study shows that multi-year ice, which is the oldest and thickest Arctic sea ice, is disappearing at a faster rate than the younger and thinner ice which can typically be found at the edges of the Arctic Ocean's floating ice cap (Comiso, 2012). According to Comiso "the average thickness of the Arctic sea ice cover is declining because it is rapidly losing its thick component, the multi-year ice. At the same time, the surface temperature in the Arctic is going up, which results in a shorter ice-forming season" (as cited in Gran & Viñas, 2012).

While the rapid decrease in multi-year ice in the Arctic Ocean will improve the possibility of navigation during all seasons, significant obstacles to shipping, such as icing from sea spray, wind chill, remoteness and its implications for rescue and emergency operations, limited reliable weather forecasts, and polar lows, will remain. During the winter and spring months ice conditions along the NSR and the TSR will remain heavy and the number of floating sea ice and icebergs, a hazard to the safety of marine transport, may increase during the early melt season as ice floes break apart and drift across the Arctic Ocean (Det Norske Veritas, 2010).

Sea ice will continue to form during the winter months, but the more hazardous multi-year ice, the principal obstacle to shipping in Arctic Ocean, will cease to exist. With it, the ice-free period along the Arctic's main shipping routes is expected to increase from around 30 days in 2010 to more than 120 days by mid-century (Byers, 2009; Borgerson, 2009).

Furthermore, the distribution of the remaining ice will not occur uniformly across the Arctic Ocean. According to Pfirman et al. sea ice will continue to collect and persist in one small area along the northern flanks of the Canadian Archipelago and Greenland. The study suggests that perennial ice is likely to survive longer in that region than anywhere else in the Arctic. The refugium does not only rely on locally created ice but is fed by drifting ice that forms originally over the central Arctic. Even the Siberian shelf seas may become a source of ice to that region (Pfirman, Tremblay, Newton & Fowler, 2010). Such distribution and flow of sea ice away from the navigational channels of the NSR and the TSR may lengthen the ice-free period along these routes. Moreover, ice-free periods along the TSR may soon exceed forecasts, as current climate models tend to underestimate the rate of sea ice retreat (Stroeve, Holland, Meier, Scambos & Serreze, 2007).

**Table 1 Maritime accessibility in 2000-2014 and 2045-2059 (Type A vessels[3], July-September)**

| Route | Length (km) | % accessible, 2000-2014 | % accessible, 2045-2059 | Accessibility change (%) relative baseline |
|---|---|---|---|---|
| Northwest Passage | 9,324 | 63% | 82% | 30% |
| Northern Sea Route | 5,169 | 86% | 100% | 16% |
| Transpolar Sea Route | 6,960 | 64% | 100% | 56% |
| Arctic Bridge | 7,135 | 100% | 100% | 0% |

Adapted from Stephenson, S.R. Smith, L.C., Agnew, J.A., (2011), Divergent long-term trajectories of human access to the Arctic. *Nature Climate Change.* (1)3*,* 156-160. doi: 10.1038/nclimate1120

While marine navigation in the Arctic will remain challenging due to the harsh environment the transition of the Arctic Ocean into a navigable seaway is well under way and climatic and sea ice conditions will continue to improve significantly over the next two decades.

## International Legal Situation

**Legal** Uncertainties & Opportunities

- Limited uncertainty along TSR compared to NSR and NWP
- TSR lies outside of EEZ but subject to UNCLOS and its High Seas regulations
- IMO treaties, several IMO instruments, and a future mandatory Polar Code apply to shipping along TSR
- Importance of port state control Paris MoU
- The Arctic Council's Search and Rescue Agreement

The legal framework for the regulation of Arctic shipping is set by the United Nations Convention on the Law of the Sea (UNCLOS) and applicable customary international law (VanderZwaag et. al. 2008).[4] UNCLOS balances the different rights and responsibilities of states in their capacities as coastal, port, and flag states in the respective maritime zones. In contrast to the NWP and the NSR, the TSR involves only limited legal uncertainties or controversies.[5] As a result "shipping companies might increasingly focus on the possibility of routes straight across the Arctic Ocean, avoiding the problems stemming from national jurisdictions" (Moe & Jensen, 2010: 5).

The 200 nm EEZ, measured from the state's baseline, which is the low water line along the coast, constitutes the most distant seaward area over which a coastal state exerts limited jurisdictional powers.[6] The TSR, even if a more southerly route closer to the NSR is used, lies outside any Arctic coastal state's EEZ and is therefore considered high seas. Hence, neither the coastal state's powers, as stipulated in UNCLOS and other marine agreements, nor Article 234, the Convention's "Arctic exception clause", apply to the TSR. In a report on governance of Arctic shipping by Dalhousie University, VanderZwaag et al. state that "[T]ransiting shipment would *only* [emphasis added] be subject to global shipping safety, security and environmental rules and standards" (VanderZwaag et al., 2008: 12).

The International Maritime Organization (IMO) exercises a key role in the implementation of the Convention's international regulation. It also coordinates matters concerning maritime safety and the prevention and control of vessel-source pollution. Arctic shipping via the TSR will be regulated in accordance with the two main IMO treaties, SOLAS 1974[7] and MARPOL 1973/1978[8] and several other IMO instruments, e.g. among others, COLREG 1972[9], London Convention 1972[10] and STCW Convention 1978/1995[11]. Additionally the IMO has already adopted Guidelines for Ships Operating in Arctic Ice-covered Waters[12] and Guidelines for Ships Operating in Polar Waters[13] both recommendatory in nature, and is currently in the progress of developing a mandatory Polar Code[14] with a targeted completion date of 2014 (IMO Report DE 56/25, 28 February 2012: Annex 16).

The code aims to supplement the mandatory construction and operation requirements of SOLAS, MARPOL, and other relevant IMO conventions, by taking into account the significant risks in polar waters, including both Arctic and Antarctic waters (IMO Report DE 56/10/1: Annex 1). The related discussions at the IMO include a number of different submissions and considerations involving all eight Arctic states, influential non-Arctic states and observers from intergovernmental organizations, e.g. the European Commission and non-governmental organizations. A report by the responsible correspondence group, led by Norway, emphasized that all sections are still under debate and that further discussion is needed (IMO Report DE 56/10/1). The US, supported by other delegations, is particularly concerned that the code could provide an international legal basis for Canadian and Russian regulations on the ship reporting and vessel traffic service system in Canada's claimed Arctic waters and requirements for ships navigating along the NSR (IMO Report DE 55/22: Section 12). In that regard an interesting scenario arises: could this implied legal justification positively affect the future of the TSR? Any answers remain highly speculative at present. Despite any controversy that may arise during the negotiations of international binding agreements, the code will ensure that the same set of standards, regulations, and rules apply to commercial navigation in the above-mentioned waters. Hence, it can be assumed that an already adopted mandatory Polar Code will regulate future shipping across the TSR as soon as this option is possible.

Port state control can also play a decisive role in the prevention, control, and reduction of maritime pollution across the TSR, as each port state has the authority under general international law to impose conditions on the entry of foreign ships into its ports. UNCLOS' Article 218 (1) stipulates that a port state can exercise its right to undertake investigations and institute proceedings, if considered relevant, with regard to pollution violations even on the high seas from any vessel, which voluntarily entered its port. Additionally several regional memoranda of understanding (MoU) on port state control regulate the inspection of vessels entering and visiting a port between different maritime authorities, which should ensure compliance with the international standards listed in the relevant MoU. For ships navigating within the Arctic Circle, the Paris MoU is potentially significant, as it applies to all Arctic states excluding the US (VanderZwaag et. al., 2008).[15] This memorandum could provide the enforcement framework of the IMO's envisaged Polar Code. As Jensen (2008) noted, effective port state control would need to enforce compulsory rules, specifically dedicated to the Arctic region and the higher regulatory standards applicable to the area. Iceland, as a potential trans-shipment hub, could play a decisive role in the implementation of port state control measures.

Yet Arctic marine shipping could potentially also be influenced by an expansion of maritime boundaries and a consequent extension of coastal states' sovereign rights as a result of the process of extending the limits of the continental shelf, based upon recommendations of the Commission on the Limits of the Continental Shelf (CLCS). The Arctic Ocean's seabed would be divided into a large area of national jurisdiction and a smaller area of international jurisdiction, regulated by the International Seabed Authority (ISA). Although hydrocarbon resource exploitation outside the EEZ of any Arctic coastal state is highly unlikely for years to come, potential installations could hamper shipping on recognized sea lanes and would need to be installed in accordance with UNCLOS and its relevant articles, e.g. Article 80 and Article 147.

In May 2011 the Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic, the first binding agreement negotiated under the auspice of the Arctic Council, was signed at the Council's ministerial meeting in Nuuk, Greenland. The agreement's objective is to strengthen search and rescue coordination and cooperation efforts in the Arctic. Hence, the instrument allocates specific search and rescue regions for each Arctic state, covering the entire Arctic Ocean, including the navigational channels of the TSR and imposes detailed legal search and rescue obligations on the Arctic states.[16]

The TSR's legal situation is considerably less complex than that of the NWP and NSR as it lies outside any Arctic coastal state's national jurisdiction. Regulations for shipping on high seas and specific guidelines related to Arctic shipping already provide a regulatory framework for the region and will affect shipping across the TSR. If these international legal instruments will indeed be sufficient for the protection of the fragile ecosystem is yet another story.

## Economic Feasibility and Risk Factors

**Economic** Uncertainties & Opportunities

- Shorter sailing distances do not necessarily translate into cost savings
- Economic challenges are based on question of liability, viability, and reliability
- Shipping across the TSR requires the development of a different kind of economic shipping optimization
- Hydrocarbon resource exploitation in the Arctic may boost importance of trans-Arctic shipping

The challenge to Arctic shipping along the TSR is not primarily a technological one,[17] but rather an economic one, based on the triad of liability, viability, and reliability. Instead of conducting a complete economic cost-benefit analysis the economic advantages of Arctic shipping are often calculated using a simplified formula: shorter sailing distances allow for faster trips and result in cost savings. Specifically, shipping operators can achieve cost savings through a reduction of number of days at sea, energy efficiency improvements due to slower sailing speeds, or a combination of both (Schøyen & Bråthen, 2011). Distance savings along the TSR can be as high as 41% compared to the traditional shipping lanes via the Suez Canal. Whereas a voyage at 17 knots[18] from Japan to Europe takes roughly 27 days via the Suez Canal, it takes just 16 days via the TSR. Shorter sailing distances factor in considerable fuel cost savings. Shipping operators also derive savings from the reduced number of days at sea, which allows a ship to make more return trips within a given time period resulting in increased revenue and potentially greater profits.

**Table 2 Sailing Distances**

| Port of Origin | Port of Destination | Distance in nautical miles | | Days at see at 17 knots | | Distance savings in % |
|---|---|---|---|---|---|---|
| | | via Suez Canal | via TSR | Via Suez Canal | Via TSR | |
| Tokyo | Rotterdam | 11,192 | 6,600 | 27.4 | 16.1 | -41 |
| Shanghai | Rotterdam | 10,525 | 7,200 | 25.8 | 17.6 | -32 |
| Hong-Kong | Rotterdam | 9,748 | 8,000 | 23.9 | 19.6 | -18 |
| Singapore | Rotterdam | 8,288 | 9,300 | 20.3 | 22.7 | +12 |

Based on the authors' calculations from Google Earth (Version 6.2.2.6613) [Computer Software]. (2012). Retrieved from earth.google.com; Portworld.com (2012). Distance Calculation. Retrieved (05.8.12) from, http://portworld.com/map; Sea-Distances.com (2012). Sea distances voyage calculator nautical miles. Retrieved (05.8.12) from, http://sea-distances.com/.

Instead of realizing time savings, operators can also adopt super-slow sailing. Due to the shorter length of the TSR, a ship going from Tokyo to Rotterdam can reduce its speed by 40% and still arrive in Japan at the same time as a ship sailing at full speed traveling through the Suez Canal. In addition, super-slow sailing may more than double a vessels' energy efficiency performance (Schøyen & Bråthen, 2011), resulting in a significant reduction of greenhouse-gas emissions. In light of dwindling global demand following the recession of 2007 and also growing awareness about climate change emissions a number of major shipping lines, e.g. Maersk, adopted super-slow sailing, which lowers speeds from the standard of 25 knots to around 12 knots. More than 100 Maersk vessels have utilized super-slow steaming since 2007 and the diesel engines on its entire fleet of more than 600 ships have been adapted to travel at super-slow speeds without sustaining damage. The adoption of super-slow sailing has saved the shipping company more than US$100 million (Vidal, 2010). If a future emissions control framework were to include global maritime traffic the reduction of emissions could also result in significant cost savings.[19] The advantages of the Northern shipping routes are also strongly connected to an international "geography of places", indicating that the economic centers of both Europe and Asia are slightly moving north, which would increase the advantages of trans-Arctic shipping over traditional routes (Verny & Grigentin, 2009).

Apart from considering distance-related cost savings, the economic viability of Arctic shipping routes is also highly dependent on the performance of the international seaborne trade at large. The sector as a whole is subject to the same shocks and uncertainties as the world economy and mirrors the performance of the wider economy (UNCTAD, 2011). Any attempt to develop a comprehensive assessment of future navigation along the TSR would thus need to take into account myriad uncertainties, part of the complex system of global trade. These variables include the fluctuations of bunker fuel costs, potentially high costs for shipping insurance and icebreaker escort requirements, vagueness of global trade forecasts, evolving marine infrastructure and technological development, differences in cost of container shipping, tanker transport, and LNG shipping, and the distinctness of AMSA's four Arctic shipping types.[20]

Global shipping operations are dependent on three key factors: predictability, punctuality, and economy-of-scale, all of which are currently limited in Arctic shipping. The combination of both a lack-of-schedule-reliability and variable transit times along the Arctic shipping routes represents a major obstacle towards the development of the TSR.[21] The majority of cargo ships that travel the world's oceans operate on regular schedules, known as liner service. In total more than 6,000 ships

(World Shipping Council, 2010), most of them container ships follow a set route calling at a number of ports to load and unload cargo, which consequently supply the concerned countries' *hinterland*. Profitability can only be assured with large-scale shipping based on stable and predictable (year-round) operations (Ragner, 2008). The global maritime industry operates on just-in-time cargo deliveries. The ability to schedule journeys a long time in advance and to guarantee uninterrupted service is considered key for container ship operators. As a result, of the four kinds of Arctic voyages undertaken in the Arctic Ocean, trans-Arctic shipping may face the most significant hurdle to become part of the global trade patterns (Lasserre & Pelletier, 2011).

Det Norske Veritas (2010) concluded that navigation across the Arctic Ocean would require significant improvements with regard to charting and monitoring. The coastal states' equipment for satellite communication and emergency response as well as "observational networks and forecasts for weather, icing, waves, and sea ice" were considered insufficient (Det Norske Veritas, 2010: 17). Yet due to magnetic and solar phenomena, electronic communication challenges above 70°-72° North, e.g. limited bandwidth and degraded Global Positioning System (GPS), will remain a major challenge for communication, navigation and search and rescue along the TSR (Emmerson & Lahn, 2012). Additionally the lack of infrastructure and support services for Arctic shipping operations amplifies safety considerations. The larger distance to relevant safe ports (ports of refuge) and the potential difficulties of reaching them due to, e.g. drifting icebergs, exacerbate navigational challenges along the TSR.

Improvements in this regard will be an important step in addressing safety and infrastructure concerns and will enhance the economic predictability of Arctic shipping in general and along the TSR in particular.[22] Additionally, the scarce availability of research and monitoring data also remains a significant obstacle for sufficient economic risk analysis.

A number of Arctic shipping routes, especially the NSR, are also subject to significant draft and beam restrictions. Ships along the NSR must pass through a number of narrow and shallow straits in the Kara and Laptev Sea. The Yugorskiy Shar Strait at the southernmost entrance from the Barents to the Kara Sea follows a channel, 21 nautical miles (nm) long and 12-30 meters deep. The Kara Strait south of Novaya Zemlya has a minimum depth of 21 meters and is 18 nm long. Along the eastern section of the NSR ships must navigate either the Dmitry Laptev Strait or the Sannikov Strait to pass through the New Siberian Islands and travel from the Laptev to the East Siberian Seas. The eastern approach of the Laptev Strait has a depth of less than 10 meters, restricting the draft of ships to less than 6.7 meters (AMSA, 2009: 23). Navigational challenges along these straits are further increased by the fact that only around 10% of the Arctic Ocean is surveyed according to modern standards (Huebert et al., 2012: 42). Ships that are too large to pass through the Panama and the Suez Canal, such as most Very Large Crude Carrier (VLCC) and Ultra Large Crude Carrier (ULCC), as well as Capesize container ships, are also too large to travel the NSR (Sœther, 1999: 36; Ragner, 2008; Lloyd's Register, 2007). The TSR, on the other hand, does not follow the shallow Siberian coastal shelf, which results in fewer draft restrictions and navigational challenges. Ships must only pass through one keyhole, the Bering Strait, between Cape Dezhnev and Cape Prince of Wales. The Bering Strait has a depth of 30-49 meters, is 46 nm wide and can accommodate all but the largest ULCCs.

To achieve economic profitability along the TSR a different kind of economic optimization needs to be developed which takes into account the lack of economic hubs, the cost associated with different types of Arctic shipping, and uncertainties with regard to investments for special equipment and insurance. A number of studies on the theoretical advantages conclude that bulk shipping will be more viable than liner shipping in the near future. Bulk dry and wet carriers, for example, follow less predictable schedules and their routes depend more on changing supply and demand of less time-sensitive items. Yet none of the studies explicitly exclude the possibility of Arctic container shipping (Verny & Grigentin, 2009; Liu & Kronbak, 2010; Lasserre & Pelletier, 2011; Schøyen & Bråthen, 2011).

Another important factor to determine the commercial feasibility of Arctic shipping rests in the hand of ship owners' intentions to pursue and develop Arctic maritime transportation. Lasserre & Pelletier (2011) conducted an empirical survey to determine ship owners' interests in Arctic shipping development; their results indicate that the scenarios of Arctic shipping remain highly speculative. The authors concluded that ship owners' intentions are rather restrained and less optimistic than they are often publicly portrayed. Both the bulk and the container sectors of the market remain cautious, indicating that the future of Arctic shipping will not become a trans-Arctic "Panamanian", but instead be used for destinational shipping and consist primarily of local traffic (Lasserre & Pelletier, 2011).

Yet corporate behavior is not necessarily complementary to or driven by national behavior. China's increasing investment in Arctic research is largely based on geopolitical considerations. The TSR would not only diversify China's supply and trade routes, but also contribute to the development of the country's northeast region. Thus, it is important to take into account considerations related to state behavior, including the potential of Iceland to become an Arctic trans-shipment hub.

## Geopolitical Uncertainties

**Geopolitical** Uncertainties & Opportunities

- Shift in economic, geographic, and political spheres of influence
- China's need to reduce strategic vulnerability and diversify trade routes
- China's aims to establish strategic partnership with Iceland
- Iceland occupies strategic location in northern Atlantic and may become a trans-Arctic shipment hub for TSR

The future development of Arctic shipping routes will not only depend on favorable climatic conditions across the Arctic Ocean, but will also be influenced by a lasting shift in economic, geographic, and political spheres of influence (Blunden, 2012). Asia's growing appetite for raw materials and hydrocarbon resources and China's rise as the world's largest exporter of manufactured goods and second-largest importer of globally shipped goods, may trigger a gradual but lasting shift in the global trade dynamics and world trade patterns (Campbell, 2012). Nearly half of China's gross GDP is thought to be dependent on shipping (Weijie, 2003). By 2030 China will dominate global trade along "17 of the top 25 bilateral sea and air freight trade routes" (PricewaterhouseCoopers, 2011a: 1). In 2010 Chinese mainland ports increased their share of total world container throughput to 24.2% (UNCTAD, 2011: XV) further strengthening their participation in global maritime businesses.[23]

Arctic transit routes represent a new link between European and Asian markets at a time when traditional transit routes through the Panama and Suez Canal are approaching their carrying capacity. World trade is expected to grow by three quarters by 2025 (HSBC, 2011) and the world cargo fleet is forecasted to grow by around 25% before the end of the decade, from 77,500 vessels in 2008 to more than 100,000 vessels above 500 deadweight tonnage (dwt) by 2018, further increasing the risk of traffic congestion and accidental collisions (Ministry of Economy Poland, 2009: 109). Existing trade routes between Europe and Asia pass through a number of strategic choke points from the Strait of Malacca to the Strait of Hormuz rendering world trade routes vulnerable to accidental or deliberate disruptions along these keyholes.

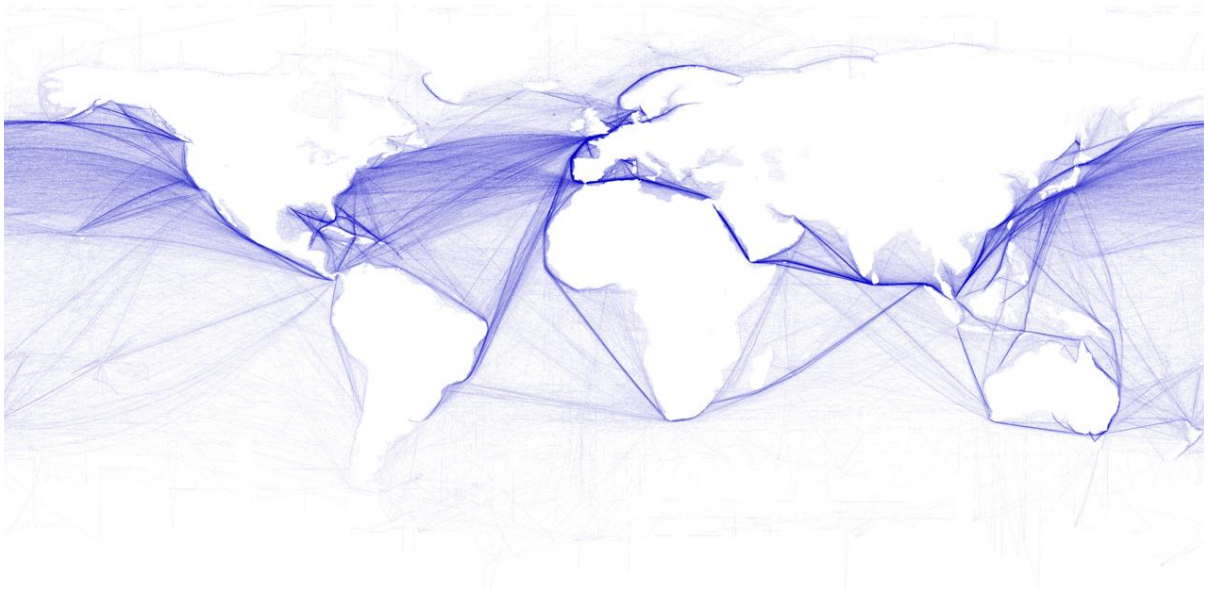

**Figure 6 Density of Commercial Shipping Activity, 2009**
Adapted by Hengl, T. (2010). *Shipping Routes*. Retrieved (04.30.12) from, http://upload.wikimedia.org/wikipedia/commons/d/dc/Shipping_routes.png. Based on Harper, B.S., Walbridge, S., Selkoe, K. A., Kappel, C.V., Michelo, F., D'Agrosa, C., … , Watson, R. (2008), A global map of human impact on marine ecosystems. *Science*. (319)5865, 948-952. doi: 10.1126/science.1149345

The closure of the Suez Canal in 1956–57 forced ships to circumnavigate the southern tip of Africa around the Cape of Good Hope. Since the 1950s, traffic on the world's oceans has increased substantially, and any interruption along a vital shipping route would have a significant effect on international trade and the global economy. The threat of piracy continues to affect shipping traffic as well. Until the 1990s, piracy was prevalent throughout the Strait of Malacca, and safety concerns remain along the eastern seaboard of Africa. A sea route through the Arctic would thus represent an alternative to the sea-lanes around the Horn of Africa and the choke points of Southeast Asia (Jian, 2011).

**Table 3 Choke points in Global Shipping, 2009**

| Chokepoints | Vessels per year | Limitation or Threat |
|---|---:|---:|
| Strait of Hormuz | 50,000 | Iran/Terrorism |
| Suez Canal | 17,228 | Terrorism |
| Strait of Malacca | 60,000 | Terrorism/Piracy |
| Panama Canal | 14,323 | Non Significant |
| Strait Bab el-Mandeb | 22,000 | Terrorism/Piracy |

Adapted from PricewaterhouseCoopers (2011b). *Transportation & logistics 2030*. Retrieved (04.30.12) from, http://www.pwc.com/en_GX/gx/transportation-logistics/pdf/TL2030_vol.4_web.pdf.

The development of Arctic shipping routes as a routine intercontinental transit route is currently considered a possibility in China (Blunden, 2012) and access to Arctic shipping routes could have profound impacts on China's trade and shipping patterns in the future (Campbell, 2012). The prospect of a navigable Arctic Ocean appeals to China as it offers not only substantial commercial opportunities in terms of distance savings, but more importantly allows it to diversify its supply and trade routes and addresses the "Malacca Strait Dilemma." President Hu described the dilemma as strategic vulnerability, which arises out of the lack of Chinese control over its key waterways and called for the adoption of new strategies to overcome the perceived vulnerability (as cited in Chen, 2010).

China's geopolitical security is highly dependent on the Strait of Malacca and the country's economic development relies on secure access to its sea-lane of communications (SLOC). Roughly 60% of transit shipping through the Strait of Malacca is bound for China (Chen, 2010) and 78% of its energy imports pass through the 1.5-mile wide channel at the southern tip of Singapore (Blunden, 2012). As a result of increasing piracy activities off the coast of East Africa, insurance premiums for ships traveling through the Suez Canal via the Gulf of Aden rose tenfold between September 2008 and March 2009 (Campbell, 2012).

A number of Chinese experts and academics support the idea of increased shipping traffic through the Arctic and see Arctic maritime traffic as geopolitical necessity for the Asian country. According to Guo Peiqing, Associate Professor at the Ocean University of China in Qingdao, Arctic shipping "will change the structure of global trade" and may result in "the emergence of a new, circumpolar super-economic belt made up of Asia, North America and Northern Europe" (as cited in Campbell, 2012: 6). Li Zhenfu of Dalian Maritime University explains, "whoever has control over the Arctic route will control the new passage of world economics and international strategies" (as cited in Jakobson, 2010: 6). In November 2010 Sovcomflot Group and China National Petroleum Corporation signed a strategic long-term cooperation agreement which sets the framework for utilizing the Northern Sea Route for transit shipments of hydrocarbons as well as delivery of oil and gas from Russia's Arctic offshore fields (Sovcomflot, 2010). China also recently announced plans for a second icebreaker to join the MV Xuě Lóng, the country's Ukrainian-built icebreaker, by 2014 (China Daily, 2012).

While China has yet to define an official Arctic policy and on the surface continues to follow a wait-and-see approach, it has begun to actively prepare for the commercial and strategic opportunities that a melting Arctic represents (Jakobson, 2010). At a workshop hosted by the Stockholm International Peace Research Institute (SIPRI) and the China Center for Contemporary World Studies on Chinese and Nordic Cooperation in the Arctic, Chinese Arctic experts referred to China as a "near-Arctic state" and described the country as a "stakeholder" (SIPRI, 2012). In a largely ice-free Arctic the strategic importance of the Nordic countries, especially Iceland, will be enhanced. Over the past decade China has continuously increased its economic cooperation with the small island nation, which may become a major Arctic shipping hub (Wade, 2008).

Iceland already serves as an important hub in air transport and the opening of the Arctic will enhance Iceland's strategic location at the entrance and exit to the Arctic Ocean. Iceland's geographical position could make it a convenient hub for cargo ships, become a port of transshipment, and would allow it to become a key provider of icebreaker services. Iceland's president, Ólafur Ragnar Grímsson, expects the Arctic sea routes to connect Asia with the Western World "in a similar way as the Suez Canal did" (as cited in Ward, 2010).

In April 2012 China's premier Wen Jiabao began his visit to a number of European countries in Iceland to further deepen the economic ties between the two countries. Two agreements, a Framework Agreement on bilateral Arctic cooperation and a memorandum of understanding in the field of marine and polar science and technology, were signed during the visit (BarentsObserver, 2012). China's strategic economic interest in the country first gained prominence during the height of the economic crisis in 2008 when it began to invest in Iceland's hard-hit economy. In 2009 Iceland became the first European country to initiate free trade negotiations with China (Shanley, 2012). According to Grímsson, the melting ice will "transform global trade like the Suez Canal in its time […]. The most efficient trading routes are going to be used by the leading trading country in the world. And these new trade routes will shorten the trading routes between China and America and Europe by almost 40 percent" (as cited in Taylor, 2012).

Iceland is key to China's strategy of sending large ice-strengthened container ships through the Arctic and utilizing ports in Iceland to then shift their cargo to smaller vessels for delivery at their destination ports (Wade, 2010). In 2007, the Icelandic Minister for Foreign Affairs, Valgerður Sverrisdóttir, highlighted Iceland's geographically ideal situation as a potential trans-shipment hub for Arctic shipping (as cited in Ministry of Foreign Affairs Iceland, 2007: 5). Embla Eir Oddsdóttir, Acting Director of the Northern Research Forum and Project Manager at Stefansson Arctic Institute in Iceland agrees, stating that the race to gain a foothold in the Arctic has already begun (as cited in

Shanley, 2012). Rob Huebert, Associate Director of the Centre for Military and Strategic Studies at the University of Calgary, sees China's arrival in the Arctic as a part of the changing geopolitical realities and a more assertive China in the international system (as cited in Sibley, 2011).

Chinese policymakers have expressed a preference for routing Arctic shipping along the TSR rather than using the NSR. The country's Arctic specialists are wary of Russia's ability "to unilaterally charge exorbitant fees for ships passing through its EEZ waters" (Jakobson, 2010), which would significantly decrease the commercial advantage of the NSR. In addition, bureaucratic hurdles to pass through the NSR remain high and no such obstacles exist along the TSR.

The potential development of the Arctic Bridge, a shipping route connecting Canada's only Arctic deep-water port in Churchill to Russia's ice-free port of Murmansk, passes in proximity of Iceland's waters and could further enhance the island nation's strategic location in the middle of the Northern Atlantic. The Arctic Bridge represents the fastest sea route connection between North America and Eurasia and reduces the transit time between the two markets by nine days compared to the St. Lawrence Seaway passage. Eimskip, a major Icelandic shipping company intends to play a significant role in the opening of these new shipping routes across the Arctic and Iceland's future as a trans-shipment hub (Ministry Foreign Affairs Iceland, 2007: 26).

## Conclusion

The earth's rapidly changing climate will continue to affect the Arctic environment and contribute to major physical, ecological, social, and economic changes. Melting of the Arctic sea ice will soon allow for extended periods of navigation in the Arctic Ocean, yet the region's navigational challenges are and will remain unique compared to all other global shipping operations (Jensen, 2008: 107). The Transpolar Sea Route represents one of three sea routes that have the potential to transform commercial shipping in the 21$^{st}$ century. Projections on the future of Arctic shipping include a number of highly variable factors and in order to arrive at a comprehensive analysis regarding the potential future development of the TSR, the authors conducted a multi-level assessment involving a discussion of environmental and climatic uncertainties, the international legal situation, economic considerations, and the importance of state behavior.

The transition of the Arctic Ocean into a navigable seaway is well under way and climatic and sea ice conditions will continue to improve significantly over the next two decades. Marine navigation in the Arctic will remain challenging during the winter and spring months when ice conditions will remain heavy and the amount of floating sea ice and icebergs may increase during the early melt season, as ice floes break apart and drift across the Arctic Ocean.

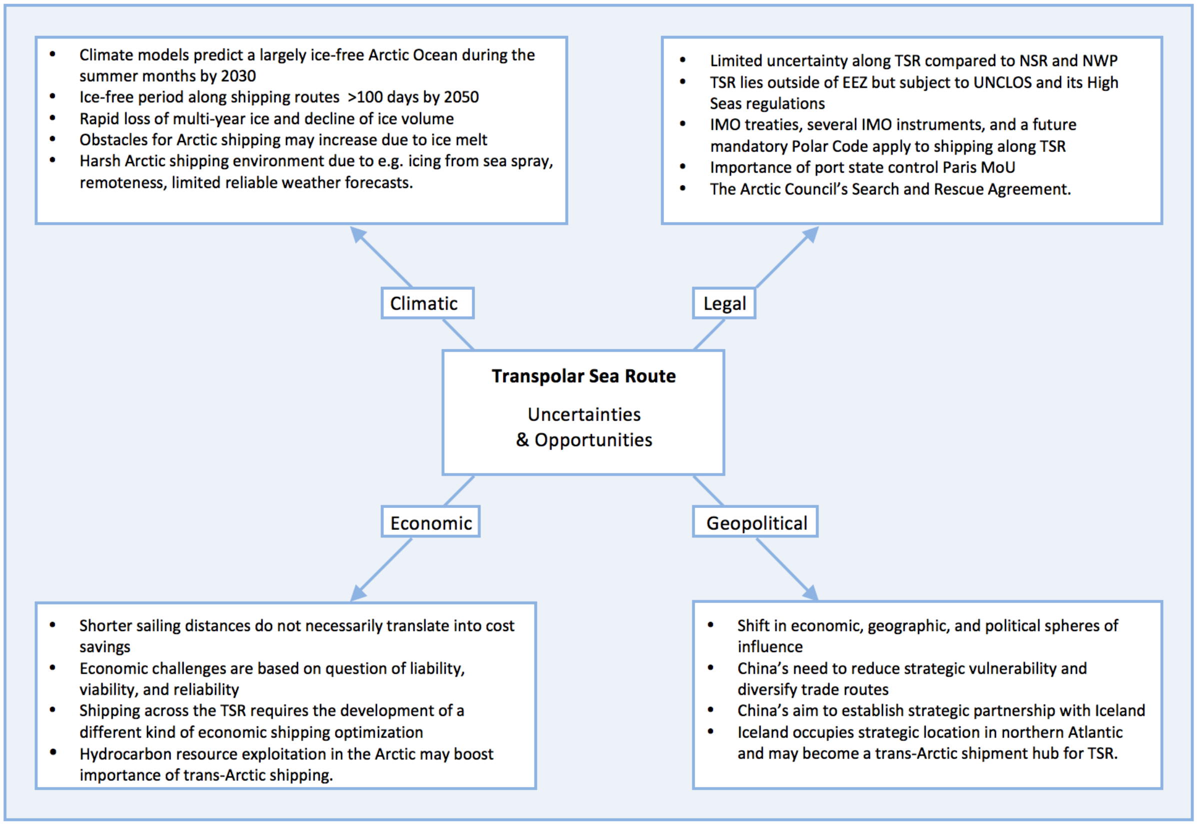


**Figure 7 Uncertainties & Opportunities of the Transpolar Sea Route**

The TSR's legal situation is without much uncertainty as it lies outside any Arctic coastal state's national jurisdiction. Regulations for shipping on high seas and specific guidelines related to Arctic shipping, including a future mandatory polar code, already provide for a legal framework in the region and will affect shipping across the TSR.

Yet shipping operators are rather skeptical towards the future development of Arctic shipping. Although time-savings always matter in the shipping business, predictability and liability are regarded as even more important. To achieve economic profitability along the TSR a different kind of economic optimization needs to be developed which takes into account the lack of economic hubs, the cost associated with different types of Arctic shipping, and uncertainties with regard to investments for special equipment and insurance. A number of studies on the theoretical advantages conclude that bulk shipping will be more viable than liner shipping in the near future, yet emphasize the potential niche factor of Arctic shipping. In that regard future hydrocarbon resource exploitation and the consequent transportation of the resources gained can be considered an essential Arctic shipping enhancer.

The opening and future development of Arctic shipping routes will not only depend on favorable climatic conditions across the Arctic Ocean, but will also be influenced by a lasting shift in economic, geographic, and political spheres of influence (Blunden, 2012). Asia's growing appetite for raw materials and hydrocarbon resources and China's rise as the world's largest exporter of manufactured goods and second-largest importer of globally shipped goods, may trigger a gradual but lasting shift in the global trade dynamics and world trade patterns (Campbell, 2012). The opening of the Arctic will enhance Iceland's strategic location at the entrance and exit of the Arctic Ocean and China aims to establish a strategic partnership with the island nation. The development of the TSR and its significant economic potential may thus in part be determined by key geostrategic considerations as the center of economic and political power continues to shift towards Asia.

## Notes

1. The central Arctic Ocean has not yet seen any commercial shipping transiting the ocean across the North Pole. Yet seven trans-Arctic voyages, conducted by icebreakers were accomplished by 2008. See PAME.
2. The Organisation for Economic Co-operation and Development (OECD) indicates that the export of Chinese goods and services make for an average of 34% of China's GDP between 2003 and 2009. See OECD (2012).
3. Type A vessel designates a 'light icebreaker.'
4. For relevant regulations and standards regarding the international private maritime law framework applicable in the Arctic region. See VanderZwaag et. al., 2008: 35-50.
5. Among others, the following papers elaborate on the legal dispute in the NWP and NSR, respectively, see Brubaker, 2005; Kraska, 2007; Pharand, 2007.
6. Yet Part VI of UNCLOS additionally defines a costal state rights with regard to its continental shelf and the potential of an extended continental shelf beyond the 200 nm margin.
7. International Convention for the Safety of Life at Sea, London, 1 November 1974 as amended (SOLAS 74).
8. International Convention for the Prevention of Pollution from Ships, London, 2 November 1973 as amended (MARPOL 73/78).
9. Convention on the International Regulations for Preventing Collisions at Sea, London, 20 October 1972.
10. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 and its Protocol of 1996.

11. International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, London, 1 December 1978, as amended (STCW 78).
12. IMO Guidelines for Ships Operating in Arctic ice-covered Waters adopted by IMO MSC/Circ.1056, MEPC/Circ.399, 23 December 2002.
13. IMO Guidelines for Ships Operating in Polar Waters adopted by IMO Assembly Resolution A.1024(26), 2 December 2009.
14. A Working Group on the development of a mandatory Polar Code was established in November 2010; See IMO Report DE 54/23, 17 November 2010, Section 13. Further relevant documents regarding the progress on a mandatory Polar Code are available at *IMODOCS*, the publicly accessible online archive of the IMO: https://webaccounts.imo.org
15. In addition the Tokyo MoU applies to the Asia-Pacific region with China's Maritime Safety Administration as member authority.
16. In that regard both the 1979 International Convention on Maritime Search and Rescue and the 1944 Convention on International Civil Aviation are stipulated as basis for search and rescue operations under the Arctic Council's agreement. See Arctic Search and Rescue Agreement, Article 7. Consequently agreement reaffirms and implements preexisting legal treaty obligations, yet now specifically covering the Arctic region.
17. Technical challenges for Arctic shipping involve the ship hull structure, the hull form, the width of ships and propulsion systems and propeller.
18. Maersk Line operated its fleet at 17 knots in 2011. See Wienberg & Bhatia, 2012.
19. The global benefits of related reduced CO2 emissions could, for example, compensate the external added costs of Arctic shipping in a global Emission Trading Scheme (ETS). See Schøyen & Bråthen, 2011.
20. With regard to the NWP and the NSR, political and legal issues, as well as potentially high transit fees also matter.
21. In that regard see Verny & Grigentin (2009) for a recent calculation on the economic viability of container shipping in the NSR.
22. In that regard satellite space system on High Elliptical Orbit (HEO), as currently used by Russia, could enhance polar coverage above 70° North.
23. Today China has two of the world's largest banks in ship financing. See UNCTAD 2011.

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**Other International Legal Instruments**

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